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ASSIGNMENT BOOKLET
SCN2261 Physics 20
Module 8 Assignment

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Physics 20

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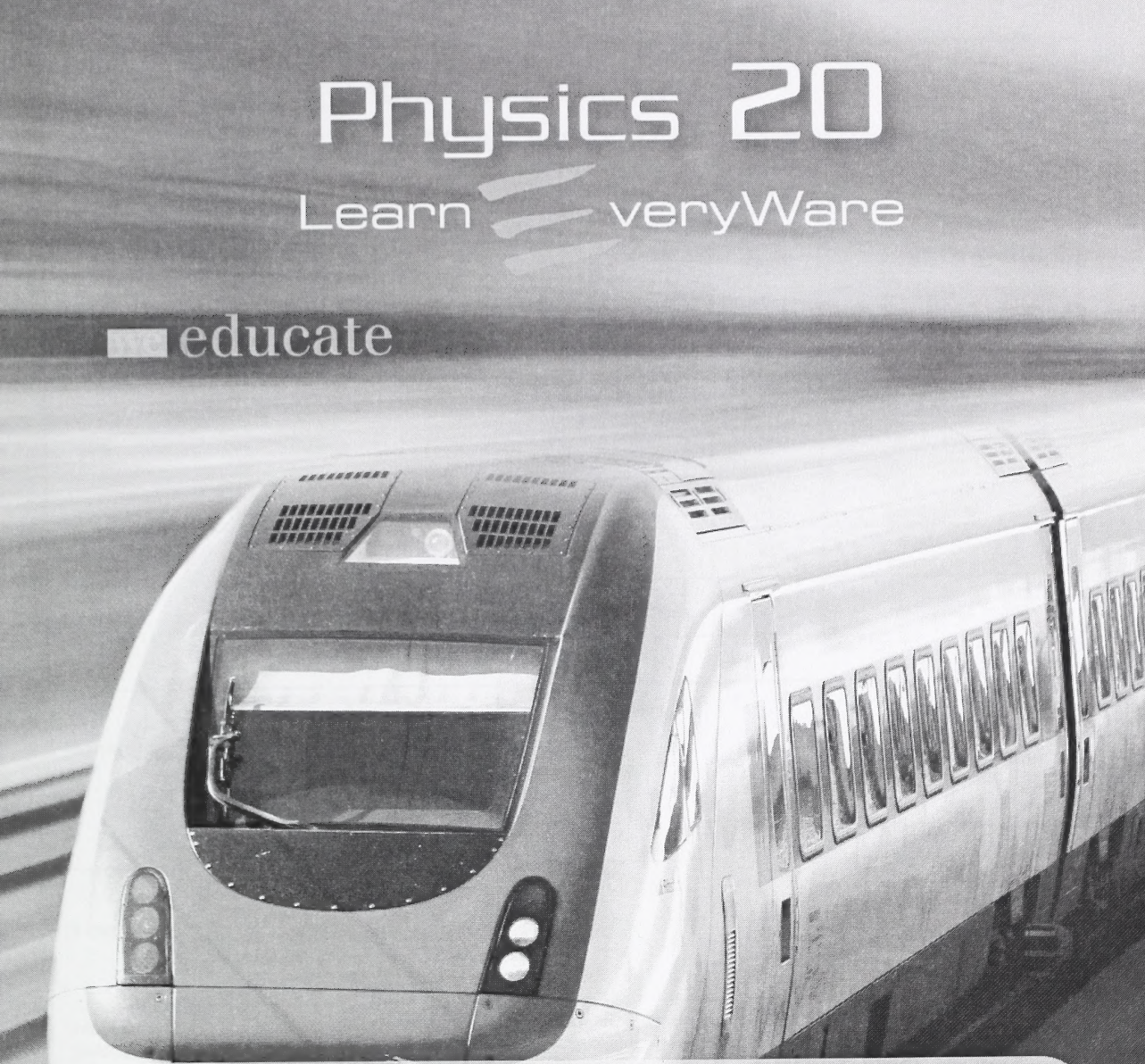

Module 8

MECHANICAL WAVES

ASSIGNMENT BOOKLET

FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Lesson 1 Assignment	20	
Lesson 2 Assignment	15	
Lesson 3 Assignment	21	
Lesson 4 Assignment	14	
Lesson 5 Assignment	27	
Lesson 6 Assignment	19	

Teacher's Comments

Physics 20
Module 8: Mechanical Waves
Assignment Booklet
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Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

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- Alberta Education, **http://www.education.gov.ab.ca**
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MODULE 8: LESSON 1 ASSIGNMENT

This Module 8: Lesson 1 Assignment is worth 20 marks. The value of each assignment and each question is stated in the left margin.

(20 Marks) **Lesson 1 Assignment: Properties of Mechanical Waves**

TR 1. Define the following terms with the aid of your physics textbook.

(1 mark) a. wave

(1 mark) b. wave front

(1 mark) c. medium

(1 mark) d. incident wave

(1 mark) e. reflected wave

(1 mark) f. wave train

(8 marks) **TR 2.** Recall the earlier definitions given in this lesson for the terms listed in the table below. How could each of these terms be defined differently based on the type of wave? A quick diagram may help you explain these.

Term	Transverse Wave	Longitudinal Wave
crest		
trough		
amplitude		
wavelength		

(2 marks) **TR 3.** Complete question 5 of "8.2 Check and Reflect" on page 410 of your textbook.

(4 marks) **Discuss**

The Indian Ocean earthquake and subsequent tsunami killed so many people because there was no warning of the impending disaster. It took hours for the first wave to reach many of the shores where widespread death and destruction occurred.

Research the events that occurred in the Indian Ocean on the morning of December 26, 2004, and submit an explanation for the following questions:

- How is it possible to predict the arrival of a tsunami in a coastal area?
- Why is it important to identify the epicentre of the event responsible for producing the tsunami?
- How does a tsunami warning system work?
- How can a tsunami warning system fail?
- Was the Indian Ocean tsunami warning system used effectively in the July 2006 Java earthquake? Why or why not?

MODULE 8: LESSON 2 ASSIGNMENT

This Module 8: Lesson 2 Assignment is worth 15 marks. The value of each assignment and each question is stated in the left margin.

(15 Marks) ## Lesson 2 Assignment: Wave Reflection

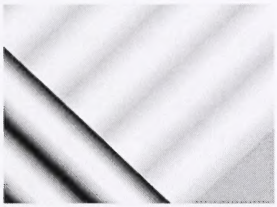
(4 marks) **TR 1.** Using the values provided in left column of the data table, set the source angle on the simulation. You can set the source angle by dragging the slider below "Source Angle" or clicking the button (#) next to "Source Angle" and filling in the value. Then click "Play," and record the angle of reflection. Although you can simply read the angle of reflection out of the angle data box, it is helpful to actually watch the reflection occur. It may help to turn on "Highlight Reflection" (☑ Highlight Reflection) in order to clearly see the reflected waves. Complete the chart.

Source Angle (θ incident)	Reflected
10.0°	
20.0°	
30.0°	
40.0°	
50.0°	
60.0°	
70.0°	
80.0°	

TR 2. For the following diagrams, sketch in the normal line and the incident and reflected rays. With a protractor, determine the angle of incidence and angle of reflection. Use the Water Reflection simulation to check your answer. In each of the images below, the reflected wave is highlighted and the incident wave appears in the background. Be careful—remember that the ray is perpendicular to the wave!

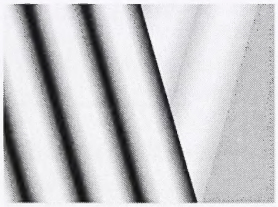
(3 marks)

a.



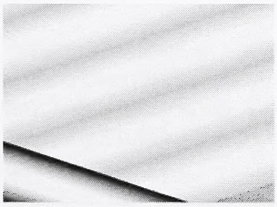
(3 marks)

b.



(3 marks)

c.



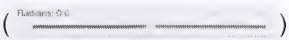
(2 marks) **TR 3.** Draw a ray diagram to show the reflection of a wave that is incident to a surface at an angle of 20.0°. Use the Water Reflection simulation to verify your answer.

MODULE 8: LESSON 3 ASSIGNMENT

This Module 8: Lesson 3 Assignment is worth 21 marks. The value of each assignment and each question is stated in the left margin.

(21 Marks) **Lesson 3 Assignment: Wave Phase, Interference, and Standing Waves**

(4 marks) **TR 1.** Complete the following graph using the radians-degrees conversion factor.

TR 2. Use the phase slider () on the simulation to investigate how wave phase affects the position of a wave (the blue wave) as it is drawn along the horizontal axis of a graph.

(1 mark) a. A negative phase or decrease in the phase shifts the wave to the _____ along the horizontal axis.

(1 mark) b. A positive phase or increase in the phase shifts the wave to the _____ along the horizontal axis.

(2 marks) c. Two waves will overlap exactly (i.e., match up) only when the phase of one of the waves is exactly 2π radians greater than the phase of the other wave. Is this statement **true** or **false**? Explain your answer.

(2 marks) **TR 3.** The green waveform at the bottom of the simulation shows the combined waveform. Sketch the waveform when the two waves are in phase or complete constructive interference. Compare the amplitude of the combined waveform with the amplitude of the individual waveforms. Which wave has the larger amplitude?

(2 marks) **TR 4.** The green waveform at the bottom of the simulation shows the combined waveform. Sketch the waveform when the two waves are completely out of phase or complete destructive interference. Compare the amplitude of the combined waveform with the amplitude of the individual waveforms. Which wave has the smaller amplitude?

(2 marks) **TR 5.** The green waveform at the bottom of the simulation shows the combined waveform. Sketch an example of the combined waveform when the two waves undergo intermediate interference, and compare the amplitude of the combined waveform with the amplitude of the individual waveforms.

TR 6. Adjust the amplitude of wave 1 to be 5 units and wave 2 to be 12 units. Choose a wavelength of 100 m. (This makes the waves large enough to be easily seen.)

(1 mark) a. What is the maximum possible amplitude of the combined wave when wave 1 and wave 2 constructively interfere?

(1 mark) b. What is the minimum possible amplitude of the combined wave when wave 1 and wave 2 destructively interfere?

(2 marks) **TR 7.** Two waves are originally in phase. If one of the waves is shifted by 4π radians, the waves will now be completely out of phase. Is this statement **true** or **false**? Explain your answer.

(3 marks)

Discuss

At some point in your life, you have probably had an opportunity to skip rope with a couple of friends. If you have one rope, you can skip by yourself or you can include two friends, each holding one end of the rope with you in the middle. Your friends are the nodes, and you are the antinode. Is it possible to skip rope with three other friends, with two of you in the middle jumping at different times?

In the discussion forum, explain how two jumpers can be in the middle in such a way that only one person has to jump at a time. In your explanation, refer to the terms *node*, *antinode*, and *frequency*.

MODULE 8: LESSON 4 ASSIGNMENT

This Module 8: Lesson 4 Assignment is worth 14 marks. The value of each assignment and each question is stated in the left margin.

(14 Marks) ## Lesson 4 Assignment: Resonating Air Columns

(3 marks) **TR 1.** A tuning fork of frequency 440 Hz is held above an air column that is gradually increased in length. What is the length of the air column that will produce the second resonance position when the speed of sound is 336 m/s?

(3 marks) **TR 2.** What is the speed of sound where a tuning fork of frequency 262 Hz produces the third resonance position above an air column that is 1.59 m in length?

(3 marks) **TR 3.** The speed of sound is 340 m/s where a tuning fork produces the second resonance position above an air column that is 49.8 cm in length. What is the frequency of the tuning fork?

TR 4. Use the Standing Waves applet to answer the following questions:

(1 mark)

a. For the third overtone when a tube that has both sides open, how many wavelengths is the length of the tube?

(1 mark)

b. For the first overtone when a tube that has one side open, how many wavelengths is the length of the tube?

(3 marks)

Discuss

A wind instrument, such as a flute or clarinet, is designed in such a way that the length of the air column can effectively be changed by opening and closing holes in the instrument. The resonant frequency that will be heard from such instruments is produced by a wave that is twice as long as the distance between the mouthpiece and the first open hole in the instrument. This wave is known as the fundamental frequency. However, an instrument will produce its own unique sound even if it has the same fundamental frequency as another type of instrument. For example, a flute and a clarinet could have the same air column length, producing the same fundamental frequency, but they don't sound the same. Why? They have different timbre or tone colour, the quality that allows you to distinguish different instruments even if they play the same note.

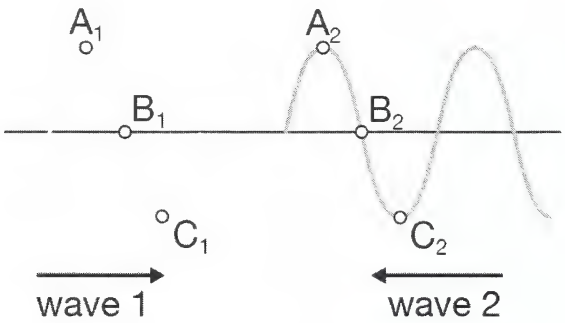
In the discussion forum, explain why these instruments must be an open air column. Using page 423 of your textbook as a source, explain how overtones give each wind instrument a unique sound even though they may resonate with the same fundamental frequency.

MODULE 8: LESSON 5 ASSIGNMENT

This Module 8: Lesson 5 Assignment is worth 27 marks. The value of each assignment and each question is stated in the left margin.

(27 Marks) **Lesson 5 Assignment: Two-Point Interference Patterns**

(4 marks) **TR 1.** The diagram below shows two waves moving towards each other. For each of the following combinations, circle whether the interference will be constructive (C), destructive (D), or intermediate (I). For example, when point A1 meets point C2, the wave will destructively interfere, producing no amplitude.



a. A_1 and A_2	**C**	**D**	**I**	e. B_1 and C_2	**C**	**D**	**I**
b. A_1 and B_2	**C**	**D**	**I**	f. C_1 and A_2	**C**	**D**	**I**
c. A_1 and C_2	**C**	**D**	**I**	g. C_1 and B_2	**C**	**D**	**I**
d. B_1 and A_2	**C**	**D**	**I**	h. C_1 and C_2	**C**	**D**	**I**

LAB 1. Complete the following table.

Number	Type of Interference	Path Difference (Number of Wavelengths)
1	destructive	2.5
2		
3		
4		
5		
6		

(2.5 marks)

a. In the right column, record the path difference that is displayed in the upper left corner of the display. Note that the simulation displays the path difference in terms of the number of wavelengths or waves.

(2.5 marks)

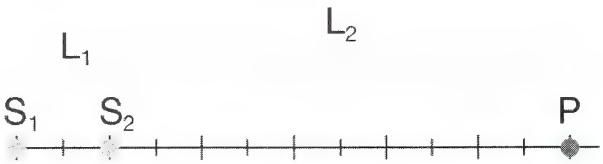
b. In the left column, list the type of interference at each point and the path difference. The simulation shows destructive interference as grey, while constructive interference alternates between white and black as seen when you press "Play". The first row is done for you.

(2 marks) **LAB 2.** Based on your recorded observations on the table, describe the connection between the interference type and path difference.

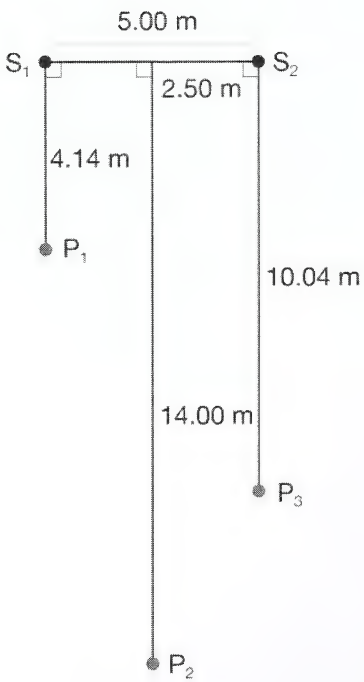
(2 marks) **LAB 3.** Using the principle of superposition, explain the relationship between constructive interference and path difference. Include a diagram with your answer.

(2 marks) **LAB 4.** Using the principle of superposition, explain the relationship between destructive interference and path difference. Include a diagram with your answer.

The figure below shows two sources (S_1 and S_2) that emit waves. The waves are identical ($\lambda = 1.0$ m) and are emitted in phase. A detector (P) is located 6.0 m away from S_1. Initially, the sources are separated by 1.0 m; however, S_2 is systematically moved closer to the detector in increments of 0.5 m.



TR 2. Two speakers (S_1 and S_2) are separated by 5.00 m and emit sound waves in all directions with $f = 440$ Hz. Three people (P_1, P_2, and P_3) are located at different distances from the speakers, as shown.



(1 mark)

a. Using the universal wave equation ($v = f\lambda$), determine the wavelength emitted by the speakers when the speed of sound is 345 m/s.

(5 marks)

b. Complete the following table. L_1 and L_2 represent the path's length from S_1 and S_2 to the person, respectively. They must be calculated using trigonometry and the data in the figure.

	To P_1 (m)	To P_2 (m)	To P_3 (m)
L_1 (m)			
L_2 (m)			
ΔL (m)			
$\frac{\Delta L}{\lambda}$			
Type of Interference			

(1 mark)

c. What is the pattern between $\frac{\Delta L}{\lambda}$ and constructive interference?

(1 mark)

d. What is the pattern between $\frac{\Delta L}{\lambda}$ and destructive interference?

(2 marks)

e. Do the three people all hear the same thing? Why or why not?

TR 3. Imagine that the images in SC 4 depict the surface of a pond. Describe the motion of a water beetle on the surface of the water when it is located at each of the following locations:

(1 mark) a. along a nodal line

(1 mark) b. along an antinodal line

MODULE 8: LESSON 6 ASSIGNMENT

This Module 8: Lesson 6 Assignment is worth 19 marks. The value of each assignment and each question is stated in the left margin.

(19 Marks) **Lesson 6 Assignment: The Doppler Effect**

TR 1. Play the simulation by pressing "Start." Observe the wave fronts produced by the moving object. Recall that wavelength is the distance between each front.

(1 mark) a. On which side of the object are the waves compressed?

(1 mark) b. Why do they appear compressed only on this side?

(1 mark) **TR 2.** Reset the simulation, and increase the source speed by dragging out the respective vector arrow. What happens to the leading wavelength as the speed of the source increases?

TR 3. Reset the simulation, and set the source speed to be equal to the speed of sound.

(1 mark) a. What is the wavelength of the sound in front of the source when it is travelling at the speed of sound?

(1 mark) b. What special name is given to the single wave front when this happens?

(2 marks) **TR 4.** A fire engine is being driven away from you at a speed of 15.4 m/s. One of the notes in its siren sequence has a fundamental frequency of 244 Hz. If the speed of sound is 338 m/s, what will seem to you to be the fundamental frequency of that particular note?

(2 marks) **TR 5.** An automobile is approaching you at a speed of 50.0 km/h and sounding its horn. The fundamental frequency of the horn sounds to you like 266 Hz. If the speed of sound is 335 m/s, what is the real fundamental frequency of the horn?

(2 marks) **TR 6.** An automobile is approaching you at a speed of 90.0 km/h and sounding its horn. The fundamental frequency of the horn sounds to you like 268 Hz. If the real fundamental frequency of the horn is 248 Hz, what is the speed of sound?

(3 marks) **D 1.** How does radar work?

(1 mark) **D 2.** What assumptions are made about radio waves in relation to mechanical waves such as sound?

(1 mark) **D 3.** How does a radar detector work?

(3 marks) **D 4.** Would a police radar gun work correctly even when the police car is in motion? Explain.

Once you have completed all of the questions, submit your work to your teacher.